Too Poor to Leave, Too Rich to Stay: Developmental and Global Health Correlates of Physician Migration to the United States, Canada, Australia, and the United Kingdom

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Objectives. We analyzed the relationship between physician migration from developing source countries to more developed host countries (brain drain) and the developmental and global health profiles of source countries.

Methods. We used a cross-section of 141 countries that lost emigrating physicians to the 4 major destinations: the United States, Canada, Australia, and the United Kingdom. For each source country, we defined physician migration density as the number of migrant physicians per 1000 population practicing in any of the 4 major destination countries.

Results. Source countries with better human resources for health, more economic and developmental progress, and better health status appear to lose proportionately more physicians than the more disadvantaged countries. Higher physician migration density is associated with higher current physician ($r=0.42$, $P<.001$), nurse ($r=0.27$, $P=.001$), and public health ($r=0.48$, $P=.001$) workforce densities and more medical schools ($r=0.53$, $P<.001$).

Conclusions. Policymakers should realize that physician migration is positively related to better health systems and development in source countries. In view of the "train, retain, and sustain" perspective of public health workforce policies, physician retention should become even more important to countries growing richer, whereas poorer countries must invest more in training policies. (*Am J Public Health.* 2008;98:148–154. doi:10.2105/AJPH.2006.095844)

The World Health Organization's (WHO's) 2006 world health report, *Working Together for Health*, highlighted the workforce issues facing health systems.[1] Both developed and developing countries have pressing shortages of nurses and physicians. Unfortunately, such staffing shortages, lack of specialist training in poorer countries, and the financial lure of the West have resulted in the migration of physicians and nurses from the mostly developing source countries to the more developed host or destination countries. Between 23% and 28% of physicians in the 4 large English-speaking countries—the United States, Canada, the United Kingdom, and Australia—are international medical graduates (i.e., they received medical degrees outside of their host countries), 40% to 75% of whom come from low- to middle-income countries.[2]

The reasons for the emigration of these health workers and the impact of these so-called fatal flows[3] or brain drains have been enumerated.[4–7] Perhaps the most worrisome aspect of this migration is that the source countries, which are largely poor and with higher disease burden than the host countries,[2,5] can ill afford to lose their physicians.[1–8] Understandably, managing physician migration remains a sore point in the pursuit of an effective and equitable health workforce and, ultimately, policies responsible for the performance of health systems.[3,8–16]

We profile the source countries that have been reported to supply the most physicians to the United States, Canada, Australia, and the United Kingdom.[2] Although previous studies have pointed out that destination countries are generally richer than source countries, they have not shown whether there are recognizable differentials in migration patterns among the source countries. We specifically address the question of whether source countries with better profiles of human resources for health, economic and developmental progress, and health status lose proportionately more or fewer physicians to these 4 destination countries than source countries with poorer profiles. It seemed possible that, as source countries became marginally richer, without careful planning, their often meager facilities would allow them to train, but not retain or sustain, better-quality physicians, who would then migrate to take up residency positions in the United Kingdom, Canada, Australia, the United States, and other affluent countries.

METHODS

Study Population and Data

We used data on the 141 source countries with the highest physician emigration rates to the United States, Canada, Australia, and the United Kingdom combined; these data were used in a recent analysis of the metrics of physician brain drain where the procedures for data extraction are detailed.[2] The physician migration data were taken from the following[2]: the American Medical Association's 2004 Physician Masterfile[17] (United States), the 2002 Southern Medical Database and the 2002 Post-MD Education Register[18,19] (Canada), the 1999 Australian Institute for Health and Welfare database and the Overseas Trained Doctors database[20] (Australia), and the 2002 Department of Health's Medical and Dental Workforce Census and the Personal and Medical Services Census (United Kingdom; data supplied by B. Sibbald, University of Manchester, April 2006). The latest available data on human resources for health came from WHO[21] and a recent publication of the Joint Learning Initiative.[7] For the economic and development variables, we relied on the World Bank's World Development Indicators database[22] and the United Nations' Human Development Report.[23] We obtained health status data from WHO. We gathered additional data on HIV/AIDS prevalence from the "global health facts" resource of the Henry J. Kaiser Family Foundation.[24] Data

from all sources were the latest reported during the period 1999 to 2004.

Measures and Metrics

To profile the source countries, we needed informative metrics for an understanding of the scale of the migration.[2,25,26] An often used metric of physician brain drain is the emigration fraction, which is expressed by the formula

$$(1) \qquad [D \div (D + S)] \times 100,$$

where D is the number of migrant physicians from a specific source country working in the 4 destination countries and S is the number of physicians currently left in that source country.[2,5] The emigration fraction, however, does not take into account the source country's population size. The size of the population served by physicians is important for understanding the fit between physician demand and supply—that is, the population-to-physician ratio.

To a get population-adjusted metric of physician migration that properly contextualized the emigration fraction, we estimated physician migration density, which for any given source country is defined as the number of physician émigrés per 1000 people in that country. This new metric, which complements the emigration fraction, is akin to the per capita measures often used in economic and public health indicators that recognize the effect of population size on such metrics. Mathematically, when the emigration fraction is constant, the physician migration density will be directly proportional to the current physician density of a source country; if expressed as a percentage, the physician migration density will be equal to the product of the emigration fraction and the physician-to-population ratio that would have been observed without migration. Therefore, physician migration density could be seen as a supplementary metric for global profiling of source countries, not a substitute for the emigration fraction. Also, both the emigration fraction and migration density metrics are specific to the pairing of source and destination countries in the sense that these metrics cannot be generalized to unknown destination countries for other unaccounted physician loss.

Other measures of human resources for health used to profile source countries were current physician density, nurse density, public and environmental health workforce density, community health workforce density (all per 1000 population),[1,7,27] and number of medical schools per million population.[28]

We used 3 different economic measures to profile source countries. Per capita gross national income is a well-known indicator of wealth that varies widely across countries. Income poverty, measured as the percentage of the population living on less than $1 a day (in terms of purchasing power parity—that is, adjusted for local cost of living),[7,27] was used to indicate the relative per capita distribution of average income; we expected that income poverty would have an association with physician migration opposite that of per capita gross national income. We also used total health spending per 100 000 population to see whether lower expenditure was related to higher physician migration.

The level of development was captured through (1) the female literacy rate (which contributes to and reflects social progress and developmental gains),[27,29,30] measured as the percentage of females aged at least 15 years who were literate, and (2) the human development index, a composite measure of the indices of life expectancy at birth, national wealth, and adult literacy rate, plus the combined gross enrollment ratio for primary, secondary, and tertiary schools.[31]

We chose HIV/AIDS prevalence among people aged 15 to 49 years and 2 standard health status measures (mortality for infants and for children younger than 5 years) to reflect the health status profiles of the source countries.

Statistical Analysis

We first calculated the means and standard deviations of all variables, highlighting the physician migration density and physician density for each of the 6 WHO world regions (Table 1). We calculated the ratios of physician migration density between different WHO regions (called here interregional ratios) and, similarly, the interregional ratios of current physician density to gain insight into whether the cross-regional pattern of migration density ratios resembled that of their current physician densities (Table 2). To adjust for the different population sizes of the studied countries, we used the standard per capita or per unit population equivalents for most of the variables. We log-transformed all variables to avoid spurious correlations between the population-adjusted variables and to ensure linearity in possibly skewed distributions.[32,33]

We used the Pearson product moment correlation coefficient to examine the associations between physician migration density on the one hand and the aforementioned human resources for health, economic, developmental, and health status measures on the other (Table 3). We created scatter plots to show the degree of correlation between physician migration density and (1) current physician density, (2) per capita gross national income, and (3) income poverty (Figure 1).

We used multiple linear regressions to examine the relationships of these major correlates to physician migration density. Because of small numbers, we excluded variables related to the public, environmental, and community health workforces. Because of collinearity among the economic and social developmental variables, we made the following choices. Per capita gross national income, total health spending, and human development index were included only as alternative equivalent variables in different models. Income poverty and, in models without human development index, female literacy were excluded. Finally, the following variables were included 1 at a time: current physician density (model 1), nurse density (model 2), medical school density (model 3), per capita gross national income (model 4), total health spending (model 5), and human development index (model 6). In models 7 to 9, we simply repeated models 4 to 6 but added dummy variables for the world regions, using Europe as a reference. To allow for some crude comparability across the variables, we present only the standardized parameter estimates (B) and their associated *P* values.

RESULTS

Table 1 gives the means and standard deviations of the measures used in this study in their natural units. There were substantial

TABLE 1—Descriptive Statistics of Countries Losing Emigrating Physicians to the United States, Canada, Australia, and the United Kingdom: 1999–2004

Measures	No. of Source Countries	Mean (SD)
Human resources for health		
No. of migrant physicians in 4 destination countries	141	1548 (5441)
No. of physicians left in source countries	141	47 022 (141 609)
Physician emigration fraction,[a] per WHO region	141	5.67 (7.99)
Africa	26	4.65 (5.80)
East Mediterranean	20	6.48 (5.72)
Southeast Asia	9	5.99 (6.92)
West Pacific	14	9.92 (11.45)
Europe	45	2.78 (5.99)
Americas	27	8.58 (10.60)
Physician migration density, per 1000 population	141	0.094 (0.224)
Africa	26	0.012 (0.032)
East Mediterranean	20	0.097 (0.173)
Southeast Asia	9	0.037 (0.054)
West Pacific	14	0.117 (0.185)
Europe	45	0.106 (0.270)
Americas	27	0.158 (0.305)
Current physician density, per 1000 population	141	1.65 (1.42)
Africa	26	0.21 (0.30)
East Mediterranean	20	1.13 (0.83)
Southeast Asia	9	0.65 (1.00)
West Pacific	14	1.05 (0.82)
Europe	45	3.15 (0.83)
Americas	27	1.60 (1.36)
Nurse density, per 1000 population	140	3.64 (3.54)
Public and environmental health workforce density, per 1000 population	49	0.11 (0.17)
Community health workforce density, per 1000 population	27	0.33 (0.48)
Medical schools per million population	141	0.58 (0.92)
Economic factors		
Per capita GNI[b]	122	8680 (8982)
Income poverty[c]	83	18.13 (21.02)
Total health spending,[b] per 100 000 population	137	601 (777)
Developmental factors		
Female adult literacy rate[d]	106	76.87 (22.99)
Human development index[e]	133	0.71 (0.17)
Health status		
HIV/AIDS prevalence among those aged 15–49 years, %	140	1.64 (3.79)
Infant mortality, per 1000 live births	141	41.43 (41.41)
Under-5 mortality,[f] per 1000 children	141	59.70 (67.33)

Note. WHO = World Health Organization; GNI = gross national income.
[a]Physician emigration fraction = $[D \div (D + S)] \times 100$, where D is the number of migrant physicians from a specific source country working in the 4 destination countries and S is the number of physicians currently left in that source country.
[b]In terms of purchasing power parity.
[c]The percentage of the population living below $ 1 a day (in terms of purchasing power parity).
[d]Percentage among the female population aged 15 years and older.
[e]A composite measure of the indices of life expectancy at birth, national wealth, and adult literacy rate plus the combined gross enrollment ratio for primary, secondary, and tertiary schools.
[f]Mortality among children younger than 5 years.

between-country variations in physician migration, human resources for health capacities, and in economic, social developmental, and health factors. It is also evident that Europe and the Americas both had significantly higher physician migration densities and current physician densities than did Africa and Southeast Asia. This point is further buttressed by the data in Table 2, which show that the interregional ratios of physician migration density mirrored those of current physician density. For instance, Africa's physician migration density is 10%, 30%, 10%, 10%, and 10% that of the east Mediterranean, Southeast Asia, the West Pacific, Europe, and the Americas, respectively, whereas its current physician density is 20%, 30%, 20%, 10%, and 10%, respectively.

Table 3 gives correlations between physician migration density and variables for human resources for health, economic progress, social and developmental progress, and health status. Physician migration density correlated positively with the standard emigration fraction ($r=0.79$, $P<.001$). Higher physician migration was associated with higher current physician ($r=0.42$, $P<.001$), nurse ($r=0.27$, $P=.001$), and public health ($r=0.48$, $P=.001$) workforce densities and medical schools per million population ($r=0.53$, $P<.001$) but not with higher community workforce density (which was available for only 27 countries; $r=0.32$; $P=.134$). Similarly, higher physician migration density was associated with higher per capita gross national income, total health spending, female literacy, and human development index. Regarding health status, healthier countries were likely to have higher physician migration per unit population compared with less healthy countries. In summary, higher physician migration density was significantly associated with higher human resources for health, relatively higher wealth and less poverty, higher health spending, better development, and higher population health status (Figure 1). Clearly, physician migration seemed to increase with increasing physician capacity and wealth but decreased with increasing poverty.

The results of the regression models show that current physician density was a positive determinant of migration, although this relationship was dependent on the influence of wealth and development (Table 4, models

TABLE 2—Interregional Ratios of Physician Migration Density and of Current Physician Density, by World Health Organization Regions: 1999–2004

	Interregional Ratio of Physician Migration Density						Interregional Ratio of Current Physician Density					
	Africa	East Mediterranean	Southeast Asia	West Pacific	Europe	Americas	Africa	East Mediterranean	Southeast Asia	West Pacific	Europe	Americas
Africa	1.0	8.1	3.1	9.8	8.8	13.2	1.0	5.4	3.1	5.0	15.0	7.6
East Mediterranean	0.1	1.0	0.4	1.2	1.1	1.6	0.2	1.0	0.6	0.9	2.8	1.4
Southeast Asia	0.3	2.6	1.0	3.2	2.9	4.3	0.3	1.7	1.0	1.6	4.8	2.5
West Pacific	0.1	0.8	0.3	1.0	0.9	1.4	0.2	1.1	0.6	1.0	3.0	1.5
Europe	0.1	0.9	0.3	1.1	1.0	1.5	0.1	0.4	0.2	0.3	1.0	0.5
Americas	0.1	0.6	0.2	0.7	0.7	1.0	0.1	0.7	0.4	0.7	2.0	1.0

Note. For each country supplying physicians to 4 major destination countries (the United States, Canada, Australia, and the United Kingdom), physician migration density is defined as the number of its migrant physicians practicing in any of those 4 countries per 1000 population of the source country. Current physician density is the number of physicians currently practicing in a particular source country per 1000 of its population.

1–6). Current nurse density appears to have had significant reverse effect until fixed effects were accounted for. The most consistent positive determinants were medical school density (a proxy for capacity and physician supply), the economic variables per capita gross national income and total health spending, and human development index, with human development index being understandably the most powerful predictor (B=0.620, $P<.001$ in the fully adjusted model). Adjustments for regional effects only attenuated these observed effects.

DISCUSSION

To our knowledge, our study is the first to indicate that source countries with better human resources for health, more economic and developmental progress, and better health status appear to lose proportionately more physicians per 1000 population than the more disadvantaged countries. These findings suggest that physician migration from the developing to the developed countries is a differential phenomenon that mirrors the source countries' capacities and economic, social, and health status. Also, to our knowledge, our study is the first to develop and use the new metric of physician migration density, which takes the source country's population into account. The results point to real, nonspurious associations between physician migration and capacity (i.e., physician supply or ability to train physicians) and development, bearing in mind that capacity in itself is a function of resources and level of development.

The negative relationship between income poverty and physician migration is also supported by a recent analysis that showed that countries with lower income poverty had higher rates of general (nonphysician) emigration.[34] This could suggest a link between patterns of physician migration and that of professionals in general. A plausible explanation is that countries that are poorer and have higher income inequalities and smaller densities of health workers also tend to have physicians who are less likely to emigrate, perhaps because they lack the necessary economic empowerment, skills, knowledge resources (such as access to medical licensing resources), and opportunities to emigrate. This explanation would fit into the old voluntarist perspective on migration in sociology, which sees such movements in terms of either internal push factors (due to stagnation at home) or external pull factors (from the promise of a brighter future in host countries).[35] Our findings would seem to validate this voluntarist model as well as the newer migration systems theory, which stresses the complex interplay of macro-, meso-, and microstructures on migration, showing that it is a result of intricate long-standing contextual developments.[36]

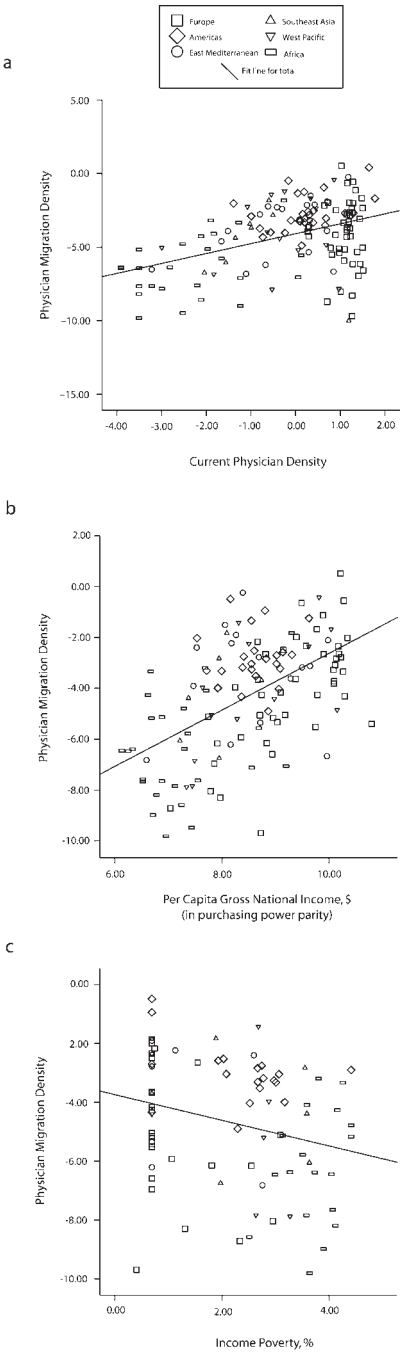
Relatively rich countries with high physician emigration, such as Thailand, South Africa, Singapore, Ireland, Syria, and India, appear to have higher training capacities than do poorer countries such as Nigeria, Ghana, and Nepal. Unfortunately, relatively rich countries may not have the solid policies and working conditions necessary for retaining physicians in a world where the medical profession has been globalized.[4,7,37] In a sense, developing and developed countries with less favorable training or working conditions than the United States and the United Kingdom are bound to lose skilled physicians. Although we have no supporting data, it is also possible that the 4 Anglophone destination countries differentially target source countries (e.g., through colonial links), which could have influenced our findings. These findings could also be explained by other factors, such as destination countries' recruitment policies, their relations with the source countries, and relations between medical schools in the host and source countries. A proper quantitative assessment of the role of factors related to destination countries would require much more data and a larger number of destination countries.

To design effective policies, policymakers need to understand the nature and context of the differentials in physician migration. For instance, reversing physician migration from Ghana, which has a life expectancy at birth of 57.0 years and has lost about 30% of its physician workforce, would only boost physician density from 0.15 per 1000 population to 0.21 per 1000. Although this would be a remarkable gain, it would still be far behind the 0.85 per 1000 population seen in Jamaica, which has a life expectancy at birth of 75.3 years, has lost 41.4% of its physician

TABLE 3—Correlations Between Physician Migration Density, per 1000 Population, and Variables for Human Resources for Health, Economic Progress, Social and Developmental Progress, and Health Status

	Physician Migration Density, *r* (*P*)[a]
Human resources for health	
Physician emigration fraction[b]	0.79 (<.001)
Current physician density	0.42 (<.001)
Nurse density, per 1000 population	0.27 (.001)
Public and environmental health workforce density, per 1000 population	0.48 (.001)
Community health workforce density, per 1000 population	0.32 (.134)
Medical schools per million population	0.53 (<.001)
Economic progress	
Per capita gross national income	0.54 (<.001)
Income poverty[c]	–0.26 (.018)
Total health spending	0.54 (<.001)
Social/developmental progress	
Female literacy[d]	0.38 (<.001)
Human development index[e]	0.56 (<.001)
Health status	
HIV/AIDS prevalence in adults aged 15-49 years, %	–0.22 (0.009)
Infant mortality rate, per 1000 live births	–0.51 (<.001)
Under-5 mortality rate,[f] per 1000 children	–0.52 (<.001)

Note. For each country supplying physicians to 4 major destination countries (the United States, Canada, Australia, and the United Kingdom), physician migration density is defined as the number of its migrant physicians practicing in any of those 4 countries per 1000 population of the source country. Current physician density is the number of physicians currently practicing in a particular source country per 1000 of its population.
[a]Two-tailed *P* value of each Pearson's correlation coefficient.
[b]Physician emigration fraction = $[D \div (D + S)] \times 100$, where D is the number of migrant physicians from a specific source country working in the 4 destination countries and S is the number of physicians currently left in that source country.
[c]Percentage of the population living on less than $1 a day (in terms of purchasing power parity—that is, adjusted for local cost of living).
[d]Percentage among the female population aged 15 years and older.
[e]A composite measure of the indices of life expectancy at birth, national wealth, and adult literacy rate plus the combined gross enrollment ratio for primary, secondary, and tertiary schools.
[f]Mortality among children aged younger than 5 years.



Note. Variables are log-transformed. Income poverty is the percentage of the population living on less than $1 a day (in terms of purchasing power parity). Current physician density is per 1000 population of source country.

FIGURE 1—Scatter plots of associations between physician migration, per 1000 population, and (a) current physician density, (b) per capita gross national income; and (c) income poverty.

workforce, and stands to achieve a physician density of 1.45 per 1000 population with migration reversal. Jamaica may lose more doctors, but it also has proportionately more of them than Ghana. To solve its physician shortage, Ghana therefore needs to train more physicians in addition to addressing policies on retaining them; it cannot rely on migration reversal alone. More cost-effective solutions, such as substituting less expensive health workers for physicians and increasing the participation of allied health workers (i.e., nonregistered health workers who are authorized to provide limited care, as distinct from physicians and nurses) in health services delivery, are necessary.

The finding that countries with emerging economies may be more prone to higher physician losses than countries with more-stagnant economies implies that poorer countries might be caught in an unfortunate dilemma: they have to tolerate poverty to retain their best and brightest,[34] but they need to break out of poverty to increase their investments in their health workforce.

If source countries are to meet their pressing health needs and achieve the Millennium Development Goals,[31] the global community must have effective policies on human resources for health. Ultimately, developing nations will have to "train, retain, and sustain" their physicians and other health workers if they are to save their health systems from complete implosion.[7,8,11,16,38–40] Policies need to be proactive, holistic, and progressive, not merely reactive.[7,39] Given Africa's urgent need to meet its health goals over the next decade,[7,40] training policies with increasing attention to "retain and sustain" strategies must be carefully crafted to avoid portraying migration reversal as a panacea. Ultimately, as Gish and Godfrey noted almost 30 years ago, "the solutions to the problem raised by these international movements [physician migration] are not to be found within the movements themselves but in necessary changes within the framework or specific national (health care) systems and, of course, the social, political and class structures in which they exist."[41(p1)]

This study has several limitations. First, data on human resources for health are notoriously scarce and of questionable

TABLE 4—Standardized Parameter Estimates (B) of the Determinants of Physician Migration Density

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
No. of source countries	141	140	131	121	130	126	121	130	126
Current physician density, B (*P*)	0.420 (<.001)	0.566 (<.001)	0.322 (.014)	0.116 (.371)	0.110 (.374)	–0.056 (.705)	0.054 (.757)	–0.015 (.928)	0.001 (.998)
Current nurse density, B (*P*)	…	–0.184 (.149)	–0.244 (.047)	–0.408 (.001)	–0.408 (.001)	–0.348 (.003)	–0.144 (.320)	–0.159 (.254)	–0.157 (.287)
No. of medical schools per million population, B (*P*)	…	…	0.468 (<.001)	0.308 (.002)	0.304 (.001)	0.295 (.003)	0.230 (.030)	0.197 (.055)	0.256 (.016)
Per capita gross national income, B (*P*)	…	…	…	0.587 (<.001)	…	…	0.552 (<.001)	…	…
Total health spending, B (*P*)	…	…	…	…	0.585 (<.001)	…	…	0.594 (<.001)	…
Human development index,[a] B (*P*)	…	…	…	…	…	0.690 (<.001)	…	…	0.620 (<.001)
Adjustment for region-specific effects, by WHO world region, B (*P*)	…	…	…	…	…	…	…	…	…
Africa	…	…	…	…	…	…	0.087 (.561)	0.020 (.887)	0.160 (.283)
East Mediterranean	…	…	…	…	…	…	0.232 (.007)	0.234 (.007)	0.223 (.009)
Southeast Asia	…	…	…	…	…	…	0.145 (.098)	0.127 (.132)	0.146 (.111)
West Pacific	…	…	…	…	…	…	0.093 (.280)	0.061 (.456)	0.095 (.266)
Europe	…	…	…	…	…	…	Ref	Ref	Ref
Americas	…	…	…	…	…	…	0.252 (.013)	0.231 (.019)	0.204 (.050)
R^2	0.176	0.188	0.318	0.449	0.434	0.439	0.501	0.487	0.475
F statistic (*P*)	29.489 (<.001)	15.761 (<.001)	19.934 (<.001)	23.820 (<.001)	24.141 (<.001)	23.857 (<.001)	12.508 (<.001)	12.747 (<.001)	11.777 (<.001)

Note. WHO = World Health Organization. In an unreported additional analysis, all models except the human development index models were also adjusted for female literacy; this did not significantly improve the models. For an explanation of the models, see "Methods" section. For each country supplying physicians to the 4 major destination countries in this study (the United States, Canada, Australia, and the United Kingdom), physician migration density is defined as the number of its migrant physicians practicing in any of those 4 countries per 1000 population of the source country. Current physician density is the number of physicians currently practicing in a particular source country per 1000 of its population.

[a]This is a composite measure of the indices of life expectancy at birth, national wealth, and adult literacy rate plus the combined gross enrollment ratio for primary, secondary, and tertiary schools.

quality. We used the most comprehensive database maintained by WHO and secondary data that have been used in recent influential analyses,[2,21,27] thus maintaining some consistency and continuity. Second, the data were cross-sectional and thus do not necessarily support causal analysis or inference. Third, there is always the danger of drawing individual physician-level inferences from this macrolevel analysis—that is, the risk of ecological fallacy.[42] Our study, like other cross-country studies,[27] at best only shows an inseparable blending of the intracountry and cross-country contextual factors that may help shape physician migration at the national level.[43] A more appropriate study would have data on the joint, multilevel distributions of individual physician and contextual (source and destination countries') determinants; at this stage of research on health worker migration, such data are a luxury.

Fourth, we were unable to assess whether these physician migration patterns reflect the general patterns seen in total migration from the source countries. Finally, our metric, physician migration density, like most indicators of human resources of health, is a static indicator of manpower loss that says little about the productivity or quality of the manpower, or even about current rate of manpower loss or its time frame.[7,25,26] An important implication of our study for future research is the need for better metrics of physician migration and human resources for health.

International physician migration is a development issue. Global health agencies such as WHO and the Organisation for Economic Co-operation and Development should incorporate the findings of this study into their work to avoid making the wrong policy investments in human resources for health.[44,45] ■

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Contributors

O.A. Arah originated the study and led the statistical analyses and writing. U.C. Ogbu and C.E. Okeke contributed to the writing and overall development of the article. All authors contributed to the conceptualization of ideas and interpretation of findings and reviewed the article.

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Human Participant Protection

No institutional review board approval was required because the study data came mostly from secondary and public domain sources and did not contain any personal information.

References

1. *World Health Report 2006: Working Together for Health.* Geneva, Switzerland: World Health Organization; 2006.

2. Mullan F. The metrics of the physician brain drain. *N Engl J Med.* 2005;353:1810–1818.

3. Chen LC, Boufford JI. Fatal flows—doctors on the move. *N Engl J Med.* 2005;353:1850–1852.

4. Hagopian A, Ofosu A, Fatusi A, et al. The flight of physicians from West Africa: views of African physicians and implications for policy. *Soc Sci Med.* 2005; 61:1750–1760.

5. Hagopian A, Thompson MJ, Fordyce M, Johnson KE, Hart LG. The migration of physicians from sub-Saharan Africa to the United States of America: measures of the African brain drain. *Hum Resour Health.* 2004;2:17.

6. Astor A, Akhtar T, Matallana MA, et al. Physician migration: views from professionals in Colombia, Nigeria, India, Pakistan and the Philippines. *Soc Sci Med.* 2005;61:2492–2500.

7. Joint Learning Initiative. *Human Resources for Health: Overcoming the Crisis.* Cambridge, Mass: The President and Fellows of Harvard College; 2004.

8. Chen L, Evans T, Anand S, et al. Human resources for health: overcoming the crisis. *Lancet.* 2004; 364:1984–1990.

9. Cheng L, Yang PQ. Global interaction, global inequality, and migration of the highly trained to the United States. *Int Migr Rev.* 1998;32:626–653.

10. Dodani S, LaPorte RE. Brain drain from developing countries: how can brain drain be converted into wisdom gain? *J R Soc Med.* 2005;98:487–491.

11. Stilwell B, Diallo K, Zurn P, Dal Poz MR, Adams O, Buchan J. Developing evidence-based ethical policies on the migration of health workers: conceptual and practical challenges. *Hum Resour Health.* 2003;1:8.

12. Ahmad OB. Managing medical migration from poor countries. *BMJ.* 2005;331:43–45.

13. Patel V. Recruiting doctors from poor countries: the great brain robbery? *BMJ.* 2003;327:926–928.

14. Pang T, Lansang MA, Haines A. Brain drain and health professionals. *BMJ.* 2002;324:499–500.

15. Adams O, Stilwell B. Health professionals and migration. *Bull World Health Organ.* 2004;82:560.

16. Stilwell B, Diallo K, Zurn P, Vujicic M, Adams O, Dal PM. Migration of health-care workers from developing countries: strategic approaches to its management. *Bull World Health Organ.* 2004;82:595–600.

17. American Medical Association. AMA physician masterfile. Available at: http://www.ama-assn.org/ama/pub/category/2673.html. Accessed September 17, 2007.

18. Canadian Institute for Health Information home page. Available at: http://secure.cihi.ca/cihiweb/dispPage.jsp?cw_page=hhrdata_smdb_e. Accessed September 17, 2007.

19. Canadian Post-MD. Education registry home page. Available at: http://www.caper.ca/Pages/main.html. Accessed September 30, 2005.

20. Australian Medical Workforce Advisory Committee annual report, 2003–04. Available at: http://www.health.nsw.gov.au/amwac/pdf/amwannual_20034.pdf. Accessed September 17, 2007.

21. World Health Organization. Global atlas of the health workforce. Available at: http://www.who.int/globalatlas/default.asp. Accessed January 20, 2006.

22. *World Development Indicators 2005 CD-ROM.* Washington, DC: World Bank; 2005.

23. United Nations Development Programme. Human development report data. Available at: http://hdrundp.org/statistics/data. Accessed January 13, 2006.

24. Henry J. Kaiser Family Foundation. Global health facts. Available at: http://www.globalhealthfacts.org. Accessed January 27, 2006.

25. Hyder AA. Third world brain drain: performance of health professionals and systems needs to be assessed. *BMJ.* 2003;327:929–930.

26. Ogbu UC, Arah OA. The metrics of the physician brain drain. *N Engl J Med.* 2006;354:528–530.

27. Anand S, Barnighausen T. Human resources and health outcomes: cross-country econometric study. *Lancet.* 2004;364:1603–1609.

28. World Health Organization. World directory of medical schools. Available at: http://www.who.int/hrh/wdms/en. Accessed January 20, 2006.

29. Subbarao KY, Raney L. Social gains from female education: a cross-national study. *Econ Dev Cult Change.* 1995;44:105–128.

30. *The Millennium Development Goals Report 2005.* New York, NY: United Nations; 2006.

31. United Nations Development Programme. Human development reports: composite indices. Available at: http://hdr.undp.org/statistics/indices. Accessed January 27, 2006.

32. Ashenfelter O, Levine PB, Zimmerman DJ. *Statistics and Econometrics: Methods and Applications.* New York, NY: John Wiley & Sons Inc; 2003.

33. Kleinbaum DG, Kupper LL, Muller KE, Nizam A. *Applied Regression Analysis and Other Multivariable Methods.* Pacific Grove, Calif: Brooks/Cole Publishing Co; 1998.

34. Kapur D, McHale J. *Give Us Your Best and Brightest: The Global Hunt for Talent and Its Impact on the Developing World.* Washington, DC: Center for Global Development; 2005.

35. Papastergiadis N. *The Turbulence of Migration.* Cambridge, England: Polity Press in association with Blackwell Publishers Ltd; 2000.

36. Castles S, Miller MJ. *The Age of Migration: International Population Movements in the Modern World.* 3rd ed. Hampshire, England: Palgrave Macmillan; 2003.

37. Eckhert NL. The global pipeline: too narrow, too wide or just right? *Med Educ.* 2002;36:606–613.

38. Nullis-Kapp C. Health worker shortage could derail development goals. *Bull World Health Organ.* 2005;83:5–6.

39. Eastwood JB, Conroy RE, Naicker S, West PA, Tutt RC, Plange-Rhule J. Loss of health professionals from sub-Saharan Africa: the pivotal role of the UK. *Lancet.* 2005;365:1893–1900.

40. Nullis-Kapp C. Efforts under way to stem "brain drain" of doctors and nurses. *Bull World Health Organ.* 2005;83:84–85.

41. Gish O, Godfrey M. A reappraisal of the "brain drain": with special reference to the medical profession. *Soc Sci Med.* 1979;13C:1–11.

42. Greenland S. Ecologic versus individual-level sources of bias in ecologic estimates of contextual health effects. *Int J Epidemiol.* 2001;30:1343–1350.

43. Greenland S. A review of multilevel theory for ecologic analysis. *Stat Med.* 2002;21:389–395.

44. Pond B, McPake B. The health migration crisis: the role of four Organisation for Economic Cooperation and Development countries. *Lancet.* 2006;367:1448–1455.

45. Arah OA. The health-worker migration crisis. *Lancet.* 2006;368:28.